Appendix A

Watershed Analysis

Nez Perce Fork, 6th code Hydrologic Unit 170102050204 (HUC 0204)
Nelson Creek, 6th code Hydrologic Unit 170102050204
Little West Fork, 6th code Hydrologic Unit 170102050203 (HUC 0203)
West Fork Bitterroot River, 6th code Hydrologic Unit 170102050305 (HUC 0305)

Mud Creek Project
Bitterroot National Forest

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The purpose of this watershed analysis is to determine whether commercial harvest of trees within default Inland Native Fish Strategy (INFISH) riparian habitat conservation areas (RHCAs) in the Mud Creek project would be consistent with the Forest Plan (USDA Forest Service, 1987) as amended by INFISH (USDA Forest Service, 1995). More specifically, would the commercial harvest meet the requirements of INFISH standards TM-1a and TM-1b (USDA Forest Service, 1995: pg. A-7).

This watershed analysis is the process used to analyze, document, and determine consistency or lack of consistency with INFISH standards TM-1a and TM-lb. The analysis follows the 6-step format described in *Ecosystem Analysis at the Watershed Scale* (Version 2.2, Regional Interagency Executive Committee [RIEC] 1995) and INFISH (USDA Forest Service, 1995: pgs. A-14 – A-15).

Step 1. Characterization of the watershed

The purpose of step 1 is to identify the dominant physical, biological, and human processes or features of the watershed that affect ecosystem functions or conditions. The relationship between these ecosystem elements and those occurring in the river basin or province is established.

In this analysis we examine the dominant physical, biological, and human features of four streams in the Mud Creek project area that could be impacted by commercial harvest of timber in RHCAs. The four streams are:

- Nez Perce Fork, the arterial stream in HUC 0204
- Nelson Creek, the largest tributary to the Nez Perce Fork in HUC 0204
- Little West Fork, the arterial stream in HUC 0203 and a major tributary to the Nez Perce Fork
- West Fork Bitterroot River, the arterial stream in HUC 0305 and the collector of all water and sediment coming out of the Nez Perce Fork watershed

These four streams are discussed below.

Nez Perce Fork

The Nez Perce Fork is the arterial stream in HUC 0204. It originates along the Idaho/Montana border near Nez Perce Pass and flows east for about 15.7 miles before

entering the West Fork Bitterroot River. The Nez Perce Fork is the largest tributary to the West Fork below Painted Rocks Dam. The lower four miles flow through mostly forested private lands; the rest occurs on the Bitterroot National Forest (NF). The lower and middle reaches of the Nez Perce Fork are primarily C channel types that eventually transition into B channel types near Fales Flat campground. Above Sheephead Creek, the B channel types steepen into A channel types in the upper portion of the watershed.

The physical features which have the greatest influence (or greatest potential influence) on the Nez Perce Fork are (1) large wood; (2) the background geology; (3) fire; and (4) climate.

Large wood is the dominant feature that forms fish habitat and influences channel morphology in the Nez Perce Fork and its tributaries. Large wood increases hiding cover for fish, affects channel shape and bank erosion, forms pools, traps sediment and nutrients, and produces spawning areas for trout. The best fish habitat in the Nez Perce Fork is associated with large wood.

The Nez Perce Fork flows through an alluvial valley bottom of granitic origin. The streambed of the Nez Perce Fork is dominated by cobble and small boulder substrates. The portions of the Nez Perce Fork below Watchtower Creek have lower amounts of sediment (particles < 2 mm diameter) than the portions above Watchtower Creek. The higher levels that occur above Watchtower Creek are believed to be of natural origin since this portion of the watershed is predominantly roadless. Sediment surveys conducted in 2019 measured surface fines at 1% < 2 mm and 4% < 6 mm in a lower reach of the Nez Perce Fork near the FR 732 bridge, and 9% < 2 mm and 26% < 6 mm in an upper reach below the Fales Flat campground.

Unlike many of the streams on the Bitterroot NF, the Nez Perce Fork has been largely unaffected by fire. Smaller fires burned in the headwaters of two of its tributaries (Sheephead Creek and Nelson Creek) in 2012 and 2017, respectively; however, the vast majority of the Nez Perce Fork drainage has not experienced a large fire in over 100 years. The overstory vegetation in the Nez Perce RHCA is dominated by mature spruce/fir forest.

The Nez Perce Fork is highly vulnerable to climate change. The NorWest Model (Isaak et al. 2017) predicts that the Nez Perce Fork will not be able to provide suitably cold water for juvenile bull trout in the year 2040.

The biological features of the Nez Perce Fork are discussed in detail in Section 4 of the Mud Creek Fisheries Biological Assessment/Evaluation. They will not be reiterated here. The key point to remember is that the bull trout population has declined throughout all portions of the Nez Perce Fork and appears to be in the process of being replaced by non-native brook and brown trout. The westslope cutthroat trout population, on the other hand, is much stronger and does not appear to be at imminent risk of replacement or displacement by non-native trout. Radio-telemetry studies have shown the Nez Perce Fork to be an important spawning destination for fluvial westslope cutthroat trout from the West Fork Bitterroot River and the upper reaches of the Bitterroot River.

The human activities that have the greatest influence on the quality of the aquatic ecosystem are (1) roads; and (2) developments on private lands. Timber harvest has not had a significant effect on the quality of the aquatic ecosystem in the Nez Perce Fork watershed. Only 2% (416 acres) of HUC 0204 is considered to be in equivalent clearcut area condition, and 53% of the HUC is either Inventoried Roadless Area or designated wilderness.

The Nez Perce Fork watershed (HUC 0204) has a high road density (3.75 miles/mile^2), with 40% of its perennial stream length located within 300 feet of a road. By far, the road with the greatest adverse affect on the aquatic ecosystem is FR 468, which is the main collector road in HUC 0204. FR 468 closely parallels the Nez Perce Fork for most of its length, and about 2.5 miles of FR 468 segments are located within 100 feet of the Nez Perce stream channel (about 2.1 unpaved segments + 0.4 paved segments). This has caused widespread, permanent reductions in overstory shade along the north side of the creek. The increased solar exposure results in warmer-than-natural stream temperatures in the Nez Perce Fork during the summer months, which in turn contributes to the decline of bull trout and the spread of non-native trout. The Nez Perce Fork is currently designated as a thermally-impaired stream by the Montana Department of Enviromental Quality (MDEQ, 2005). Thermograph data indicates that 7-day mean-maximum temperatures at stream mile 1.0 are in the 17-19° C range, while those at stream mile 11.0 are in the 14-16° C range. The trend at both sites has been increasing, and neither site is able to meet its water quality goal.

Roads have a greater adverse effect on stream temperatures in the Nez Perce Fork than they do on sediment levels. The Nez Perce Fork contains a relatively clean, cobble and boulder-dominated substrate despite HUC 0204's high road density and the near-stream segments of FR 468. The grade of FR 468 is nearly flat and the near-stream segments are graveled, both of which reduce its potential for sediment delivery. The 2019 sediment surveys using the PIBO methodology measured surface fines at 1% < 2 mm and 4% < 6 mm in a lower reach of the Nez Perce Fork near the FR 732 bridge, and 9% < 2 mm and 26% < 6 mm in an upper reach below the Fales Flat campground. The irony in these numbers is that the higher percentages occur in the portions of the Nez Perce Fork that drain unroaded lands, while the lower percentages are found in the reaches that drain roaded and managed lands. Geology is thought to be the reason. The small fish-bearing tributaries to the Nez Perce Fork (Two, Tough, Flat, Peyton, Fales, Cone, Nez Perce trib 8.0) have surface fine levels ranging between 3-36% < 2 mm and 9-60% < 6 mm. Fales Creek, a stream located in the Blue Joint Wilderness Study Area, has the highest levels.

The Nez Perce Fork averages 65 INFISH large wood pieces per mile, which meets its INFISH Riparian Management Objective but is below its natural potential. The near-stream location of FR 468 has resulted in a permanent reduction in wood recruitment to the stream channel. The recent occurrence of beetle epidemics in 2002-07 (Douglas fir bark beetle) and 2008-14 (mountain pine beetle) has helped to offset this somewhat. The epidemics killed hundreds to thousands of mature conifers in the Nez Perce RHCA. Many of these trees have been recruited to the Nez Perce Fork stream channel in recent years, and many are still standing in the RHCA and will be recruited in future years.

The lower four miles of the Nez Perce Fork flow through mostly private lands that have generally been lightly developed. There are approximately a dozen homes that are located within 150 feet of the stream channel, along with their associated out-buildings, driveways, and roads. This has resulted in some scattered, small increases in solar exposure and reductions in large wood recruitment. None of the private developments are significant sediment sources.

The portion of the Nez Perce Fork that is located adjacent to the proposed RHCA harvest unit (Photo 1) is a C3 type channel with a baseflow wetted width between 25 and 30 feet. The stream bottom is dominated by cobbles and small boulders and sediment levels are low (< 5% < 6 mm diameter). Large wood recruitment potential is unaffected by man's activities and controlled by natural processes. There are numerous standing snags within one site potential tree length of the stream channel. With the exception of the beetle-killed trees, shade levels in the RHCA are intact. At the extreme east end of the proposed RHCA unit, the Nez Perce Fork flows northwest towards FR 468 and gets

close to the road for a couple hundred feet (Photo 1). In this spot, wood recruitment potential and stream shade is locally reduced along the north bank because of the near-stream location of FR 468.

Nelson Creek

Nelson Creek is the largest tributary to the Nez Perce Fork in HUC 0204. Nelson Creek originates in an alpine cirque basin between Boulder and Bare Peaks and flows southeast for about 3.8 miles before entering the Nez Perce Fork. Nelson Creek enters the Nez Perce Fork about two miles upstream from its confluence with the West Fork Bitterroot River. Nearly all of Nelson Creek is located on the Bitterroot NF. Nelson Creek is a steep A channel stream with step pool morphology. Its streambed is dominated by cobble and boulder substrates.

The physical features which have the greatest influence (or greatest potential influence) on Nelson Creek are (1) large wood; (2) the background geology; (3) fire; and (4) climate.

Large wood is the dominant feature that forms fish habitat and influences channel morphology in Nelson Creek. The best fish habitat in Nelson Creek is associated with large wood. Nelson Creek averages 76 INFISH woody debris pieces per mile, which meets its INFISH Riparian Management Objective and is near its natural potential. With the exception of the area surrounding one small road crossing (FR 468), wood recruitment is controlled by natural processes.

The Nelson Creek watershed is comprised of granitic geology, which is a naturally erosive landtype. The streambed of Nelson Creek is dominated by cobble and boulder substrates, with low levels of sediment. Sediment surveys conducted in 2019 measured surface fines at 1% < 2 mm and 4% < 6 mm in Nelson Creek below FR 468.

The Nelson Creek watershed is predominantly unburned. In 2017, a 350-acre fire occurred in the middle portion of the watershed which burned a small portion of the Nelson Creek RHCA at low to moderate severity. Approximately 272 acres were burned at low severity during a spring, 2019 prescribed burn. In one two-acre spot bordering Nelson Creek, a jackpot of slash left behind by a 2017 suppression line burned at high severity in the RHCA. Overall, the majority of the overstory vegetation in the Nelson RHCA has been unaffected by fire and is dominated by mature spruce/fir forest.

Although colder than the Nez Perce Fork, Nelson Creek is still vulnerable to climate change. The NorWest Model (Isaak et al. 2017) predicts that Nelson Creek has a 25-50% probability of providing suitably cold water for juvenile bull trout in the year 2040.

Nelson Creek contains a healthy population of westslope cutthroat trout, with lesser numbers of bull and brook trout. Bull trout are present at low densities throughout the lower 2.1 miles of Nelson Creek. Brook trout are incidental and generally confined to the lower mile. Westslope cutthroat trout are common in the lower 2.3 miles. Above that point, gradient barriers block upstream distribution. Westslope cutthroat trout are also present in Nelson Lake in the headwaters. With the exception of a few brook trout in its lower mile, the fishery in Nelson Creek is may be close to its natural condition.

The human activities that have the greatest effect on the quality of the aquatic ecosystem in Nelson Creek are (1) irrigation diversions; and (2) developments on private lands adjacent to the stream corridor. There has been minimal timber harvest in the Nelson Creek watershed, and the light nature of the harvest that has occurred has had an insignificant effect on the quality of the aquatic ecosystem in Nelson Creek. About 75% of the Nelson Creek watershed is either Inventoried Roadless Area or designated wilderness.

Three small irrigation ditches exit the lower mile of Nelson Creek. The ditches provide water for adjacent private landowners. None of the diversions are screened, and low numbers of juvenile bull trout (and higher numbers of juvenile westslope cutthroat trout) are present in the ditches. Collectively, the ditches cause a small reduction in the wetted perimeter of Nelson Creek during late summer and autumn base flows. Also, because the diversions are unscreened, it is likely that some juvenile bull trout and westslope cutthroat trout become trapped and die in the ditches every year.

The Nelson Creek RHCA crosses about a dozen acres of private land a short distance upstream from the FR 468 crossing. One home is located about 150 feet from Nelson Creek; four others are located about 250 feet from Nelson Creek. The riparian overstory is generally functioning naturally (wood recruitment and shade) on the private lands. None of the private developments are significant sediment sources.

The portion of Nelson Creek that is located adjacent to the proposed RHCA harvest unit (Photo 1) is a A2/A3 type channel with a baseflow wetted width of about 15 feet. The stream bottom is dominated by cobbles and boulders and sediment levels are low (< 5% < 6 mm diameter). With the exception of the FR 468 crossing, wood recruitment potential is unaffected by man's activities and controlled by natural processes, and shading of the stream channel is intact.

Little West Fork

The Little West Fork is the arterial stream in HUC 0203 and one of the major tributaries to the Nez Perce Fork (along with Sheephead and Watchtower creeks). The Little West Fork originates high in the Bitterroot Range along the Montana/Idaho border and flows southeast for about 9.2 miles before entering the Nez Perce Fork. The Little West Fork enters the Nez Perce Fork about two miles upstream from the mouth of Nelson Creek, and about four miles upstream from the Nez Perce Fork's confluence with the West Fork Bitterroot River. About 0.5 miles of the Little West Fork flows across private land (stream mile 0.5 to 1.0 on the Gene Jones ranch); the rest is located on the Bitterroot NF. Below Soda Springs Creek, the Little West Fork contains a mix of B and C channel types. Above Soda Springs Creek, A channel types predominate with smaller inclusions of B and C types.

The physical features which have the greatest influence (or greatest potential influence) on the Little West Fork are the same as those that affect the Nez Perce Fork and Nelson Creek, namely (1) large wood; (2) the background geology; (3) fire; and (4) climate.

Large wood is the dominant feature that forms fish habitat and influences channel morphology in the Little West Fork. The best fish habitat in the Little West Fork is associated with large wood. Large debris jams are responsible for several long side-channels that have formed over the past couple of decades between the FR 468 and FR 5635 bridges. The lower mile of the Little West Fork is naturally unstable due to the channel shaping force of large wood recruitment. The Little West Fork averages 145 INFISH large wood pieces per mile, which meets its INFISH Riparian Management Objective and is near its natural potential. With the exception of small areas surrounding a few bridge crossings, wood recruitment is controlled by natural processes and is functioning at its natural potential.

The Little West Fork watershed is comprised of granitic geology, which is a naturally erosive landtype. The streambed of the Little West Fork is dominated by cobble and boulder substrates, with low levels of sediment. Sediment surveys conducted in 2019

measured surface fines at 0.6% < 2 mm and 3% < 6 mm in the Little West Fork below Soda Springs Creek, and at 0.01% < 2 mm and 1% < 6 mm above Soda Springs Creek

The Little West Fork watershed is unburned. It has not experienced a large fire in over 100 years. The overstory vegetation in the Little West Fork RHCA has been unaffected by fire and is dominated by mature spruce/fir forest.

The Little West Fork and its tributaries are highly vulnerable to climate change. The NorWest Model (Isaak et al. 2017) predicts that the portions of the Little West Fork, Soda Springs Creek, and Sentimental Creek that currently support fish will not be able to provide suitably cold water for juvenile bull trout in the year 2040. Headwaters reaches of those streams (where no fish currently reside due to downstream gradient barriers) are predicted to have < 25% probability of providing suitably cold water for juvenile bull trout in the year 2040 (Isaak et al. 2017).

The biological features of the Little West Fork are discussed in detail in Section 4 of the Mud Creek Fisheries Biological Assessment/Evaluation. They will not be reiterated here. The bull trout population in the Little West Fork appears to be in better shape than in the Nez Perce Fork, but the threat of replacement/displacement by non-native brook and brown trout is still present. The westslope cutthroat trout population is currently strong and stable.

Human activities are currently having minimal effects on the quality of the aquatic ecosystem in the Little West Fork. Road density in HUC 0203 is (1.05 miles/mile^2), and 7% of the perennial stream length is located within 300 feet of roads. There are only five road crossings of fish-bearing streams in the HUC; four are bridges, one is a stream simulation culvert, and none are significant sediment delivery points. 80% of HUC 0203 is either Inventoried Roadless Area or designated wilderness. Only 2% (311 acres) of HUC 0203 is considered to be in equivalent clearcut area condition

There is one irrigation diversion on the Little West Fork (below the FR 5635 bridge) that removes about 25% of the stream's base flow in late summer. The point of diversion is unscreened, and the ditch provides summer irrigation water for the hayfields on the Gene Jones ranch. Some bull trout and westslope cutthroat trout get entrained in the ditch every summer, and it is unknown if they are able to escape back into the Little West Fork when the ditch is shut off in the fall, or if they become stranded and perish.

HUC 0203 is nearly all National Forest land. There are 197 acres of private land in the HUC, which comprises 1.3% of the HUC's total area. The private land consists of a single ownership (Gene Jones ranch). About 0.5 miles of the lower Little West Fork flows the ranch. The riparian area through the ranch is ungrazed and is generally intact. Overall, the water and sediment regimes in HUC 0203 are controlled by natural processes with the only significant impact being the late summer water removal from the irrigation diverson on the Gene Jones ranch.

The portion of the Little West Fork that is located adjacent to the proposed RHCA harvest unit (Photo 2) flows through a mature spruce bottom in two side-by-side B3 channels with the west channel carrying the majority of the base flow. The stream bottoms of both channels are dominated by cobbles and small boulders with low (< 4% < 6 mm diameter) sediment levels. The portion of the RHCA that borders the proposed harvest area to the east is flat, densely forested, and naturally unstable. It has seen the formation and drying up of several smaller stream channels over the decades. New channels periodially form when large spruce growing along the banks tip over and pull up their rootballs. The forest floor contains a large quantity of downed wood.

West Fork Bitterroot River (HUC 0305 portion)

HUC 0305 contains the lower 14.4 miles of the West Fork Bitterroot River (West Fork) between the mouth of the Nez Perce Fork and the confluence with the Bitterroot River. The West Fork flows down the middle of HUC 0305 and is the arterial stream in the HUC. The HUC 0305 portion of the West Fork is a large (75 to 125 feet base flow wetted width), B3/C3 channel dominated by clean cobble and boulder substrates. The West Fork Highway is located within 300 feet of the river throughout most of its length in HUC 0305. The three largest tributaries to the HUC 0305 portion of the West Fork are the Nez Perce Fork, Boulder Creek, Trapper Creek, and Piquett Creek. These tributary watersheds have their own 6th code HUCs and are not included in HUC 0305. The tributaries that are included in HUC 0305 are small A channel streams such as Pierce, Baker, Lloyd, Violet, Christisen, Applebury, Lavene, Steep, and Ward creeks.

The physical features which have the greatest influence (or greatest potential influence) on the HUC 0305 portion of the West Fork are (1) the background geology; (2) fire; and (3) climate.

Large wood plays a different role in the HUC 0305 portion of the West Fork than it does in the Nez Perce Fork, Nelson Creek, and the Little West Fork. In the Nez Perce Fork, Nelson Creek, and the Little West Fork, large wood is the dominant habitat-forming feature, creating the most pools and providing the best hiding cover. In the HUC 0305 portion of the West Fork, channel meanders form the best habitat (i.e. most pools), with large wood being more of a complementary habitat component. The HUC 0305 portion of the West Fork is too large for wood to be able to span the river channel and form main channel debris jams and pools. As a result. large wood occurs in scattered locations along the lower velocity edges of the river where it provides some hiding cover at higher flows. At the lower end of HUC 0305 near Conner, large wood also helps to form lateral scour pools and undercut banks. The HUC 0305 portion of the West Fork averages 33 INFISH large wood pieces per mile, which meets its INFISH Riparian Management Objective but is below its natural potential. Highway encroachment and riverfront developments on private lands have permanently reduced wood recruitment along some portions of the West Fork in HUC 0305.

The HUC 0305 portion of the West Fork flows through alluvial valley bottom deposits of granitic origin. The riverbed is dominated by cobble and boulder substrates, with low amounts of sediment (particles < 2 mm diameter). Sediment surveys conducted in 2019 measured surface fines below the mouth of the Nez Perce Fork at 1% < 2 mm and 2% < 6 mm. Further downstream near the mouths of Violet and Piquett creeks, percent surface fines averaged 1-5% < 2 mm and 3-7% < 6 mm.

The HUC 0305 portion of the West Fork is designated as a sediment impaired stream (MDEQ, 2005). The portion of the river below Painted Rocks Dam is considered to be "sediment starved" as a result of the sediment capture by Painted Rocks Dam (MDEQ, 2005: section 3.0, pg 127). The sediment data that was collected in 2019 is supportive of the sediment-starved condition.

HUC 0305 has been minimally affected by fire over the past century. A small amount of acreage burned in the lower portion of the HUC in 2000, but the RHCA along the West Fork was unburned. There is certainly potential for a large fire to occur in the HUC in the future as large expanses of wilderness and unroaded lands contain closed canopy forests with high fuel loads that have not experienced fire in a long time.

The HUC 0305 portion of the West Fork is already borderline too warm for juvenile bull trout during the summer months (mean August temperature in 2018 was 13.5° C), and

is highly vulnerable to becoming unsuitable over the next couple of decades. The NorWest Model (Isaak et al. 2017) predicts that the HUC 0305 portion of the West Fork will not be able to provide suitably cold water for juvenile bull trout in the year 2040.

The biological features of the West Fork are discussed in detail in Section 4 of the Mud Creek Fisheries Biological Assessment/Evaluation. They will not be reiterated here. The key point to remember is that there are very few bull trout left in the HUC 0305 portion of the West Fork, and the migratory life history form is hanging on at precariously low numbers. The outlook for westslope cutthroat trout is better, but there are hybridization issues with rainbow trout, and the brown trout population is expanding.

The HUC 0305 portion of the West Fork is substantially affected by human activities, including: (1) water releases from Painted Rocks Reservoir; (2) the West Fork Highway corridor and other roads; and (3) developments on private lands. Timber harvest has occurred in scattered areas along the roaded portions of the HUC, but recent harvests have been selective in nature and have not had a large effect on the quality of the aquatic ecosystem in the West Fork. About 4% (881 acres) of HUC 0305 is considered to be in equivalent clearcut area condition, and 18% of the HUC is either Inventoried Roadless Area or designated wilderness.

River discharge in HUC 0305 is regulated by water releases from Painted Rocks Reservoir. From late September until April-ish, outflows from the reservoir generally match inflows, and flows in the HUC 0305 portion of the West Fork approximate natural conditions. When the reservoir is filling in the spring, flows in the lower river are lower than natural. Water releases from the reservoir typically commence in early to mid July, depending on the wetness of the spring and early summer. When releases commence, flows are higher than natural in the lower river from mid summer through the end of releases in late September.

Under natural conditions, the morphology of the river channel in HUC 0305 was primarily controlled by discharge. At high flows, the West Fork was free to migrate across its floodplain. Now, the morphology of the river channel is controlled by water releases from Painted Rocks Reservoir and is constrained from meandering by the West Fork Highway and other private developments. Prior to the construction of Painted Rocks Dam in 1938, the HUC 0305 portion of the West Fork was more sinuous with more braiding, gravel bars, and pools. Since regulation of river flows began nearly 80 years ago, the river channel in HUC 0305 has become more of an armored single thread channel with less sinuousity and braiding, fewer gravel bars, and fewer pools.

The West Fork Bitterroot River (all reaches) is designated as a thermally impaired stream (MDEQ, 2005). Below Painted Rocks Dam, summer and autumn river temperatures are strongly influenced by water releases from Painted Rocks Reservoir. The Montana Department of Natural Resources and Conservation (DNRC) is the agency that operates Painted Rocks Dam. DNRC releases water from the reservoir in July through September. When water is initially released from the reservoir (in most years, releases start around mid-July), river temperatures in HUC 0305 immediately cool for a couple of weeks and then gradually warm up again in August and September as the hyoplimnetic water in the reservoir is depleted and the warmer surface waters are passed downstream. In some years, the maximum annual river temperatures in HUC 0305 occur in the month of July prior to the start of water releases. In other years, maximum river temperatures have occurred in the latter part of August when temperatures in the unregulated streams are already cooling. Mean-maximum temperatures at the lower end of HUC 0305 (river mile 1.2) typically range between 18-

21° C. The TMDL goal is < 15° C, which appears to be unattainable in the current climate.

In addition to the effect of water releases, shade losses also play an important role in the thermal impairment of the West Fork Bitterroot River. MDEQ conducted a shade study in the Bitterroot Headwaters TMDL and found that of the 199,396 linear feet of the West Fork's length, 52,093 feet (26%) had lost shade as a result of main roads such as the West Fork Highway, and 16,788 feet (8%) had lost shade because of secondary roads and impervious surfaces (Montana DEQ, 2005: pg. 212). In HUC 0305, about 10,032 feet (1.9 miles) of the West Fork Highway is located within 100 feet of the river. This affects about 13% of the river's length in HUC 0305. Shade losses are most pronounced along those near-stream segments. There are also approximately 40 private residences, along with assorted outbuildings and secondary roads, that are located within 300 feet of the West Fork in HUC 0305. These developments have also reduced shading along the West Fork in scattered locations.

The portion of the West Fork that is located adjacent to the proposed RHCA harvest unit (Photo 3) is a B3 type channel with a baseflow wetted width of 75-100 feet. The stream bottom is dominated by cobbles and boulders and sediment levels are low (< 3% < 6 mm diameter). The West Fork Highway is located within 50-100 feet of the west bank and that entire side of the river is confined by highway rip-rap. The east bank is rocky with some scattered large wood that has been pushed up along the high water mark. At base flows, the wood is mostly stranded out of the water on the rocky banks. It only provides a limited about of hiding cover when the river is near bankfull.

Step 2. Identification of issues and key questions

The purpose of step 2 is to focus the analysis on the key elements of the ecosystem that are most relevant to the management questions and objectives, human values, or resource conditions within the watershed.

The key elements of the ecosystem that could potentially be affected by commercially harveting trees in RHCAs are:

- Large wood recruitment
- Shade
- Sediment delivery

The key questions to answer are:

1. How would the commercial harvest of trees (live and dead) in the RHCAs affect wood recruitment, shade, and sediment in the Nez Perce Fork, Nelson Creek, the Little West Fork, and the West Fork Bitterroot River?
2. Would the commercial harvest in the RHCAs be consistent with the Forest Plan as amended by INFISH?

In order for the commercial harvest to be consistent with the Forest Plan, it would have to meet all of the requirements of INFISH standards TM-1a and TM-1b (USDA Forest Service, 1995: pg. A-7).

INFISH standard TM-1a states:

> ***TM-1a****: Where catastrophic events such as fire, flooding, volcanic, wind, or insect damage result in degraded riparian conditions, allow salvage and fuelwood cutting in RHCAs only where present and future woody debris needs are met, where cutting would not retard or prevent attainment of other Riparian Management Objectives, and where adverse effects can be avoided to inland native fish. For priority watersheds, complete watershed analysis prior to salvage cutting in RHCAs.*

There are five requirements that must be met in order to meet INFISH standard TM-1a. These requirements apply to the harvest of the dead and dying trees in the RHCAs.

1. Insect damage has resulted in degraded riparian conditions.
2. Present and future woody debris needs are being met in the streams adjacent to the salvage areas.
3. Salvage harvest activities would be implemented in a manner that does not retard (slow down) or prevent the attainment of the Riparian Management Objectives for pools, water temperature, and stream channel dimension.
4. Salvage harvest activities would not have adverse effects on fish; and
5. A watershed analysis is completed that documents how INFISH standard TM-1a would be met by allowing salvage harvest to occur within the RHCAs.

INFISH standard TM-1b states:

> ***TM-1b****: Apply silvicultural practices for Riparian Habitat Conservation Areas to acquire desired vegetation characteristics where needed to attain Riparian Management Objectives. Apply silvicultural practices in a manner that does not retard attainment of Riparian Management Objectives and that avoids adverse effects on inland native fish.*

There are three requirements that must be met in order to meet INFISH standard TM-1b. These requirements apply to the harvest of live trees within the RHCAs.

1. Silvicultural treatments (manual or commercial) are needed to create vegetative conditions that help to attain the Riparian Management Objectives for pools, large wood, water temperature, stream channel dimension.
2. Silvicultural treatments would be implemented in a manner that does not retard (slow down) or prevent the attainment of the Riparian Management Objectives; and
3. Silvicultural treatments would not have adverse effects on fish.

It is important to emphasize that in order to meet INFISH standards TM-1a and TM-1b, all of the requirements listed above in Step 2 must be met, not just some or most of them.

Step 3. Description of current conditions

The purpose of this step is to develop information relevant to the issues and key questions identified in step 2. The current range, distribution, and condition of the relevant ecosystem elements are documented.

In the Mud Creek project, there are three areas where commercial harvest of live and dead trees is proposed within RHCAs. These areas are referred to as “area 1”, “area 2” and “area 3” in this analysis. The three areas contain about 19 acres of proposed harvest within RHCAs.

Step 3 individually analyzes each of the three areas where harvest of live and dead trees is proposed within RHCAs. The purpose of this step is to answer the two key questions identified above in Step 2:

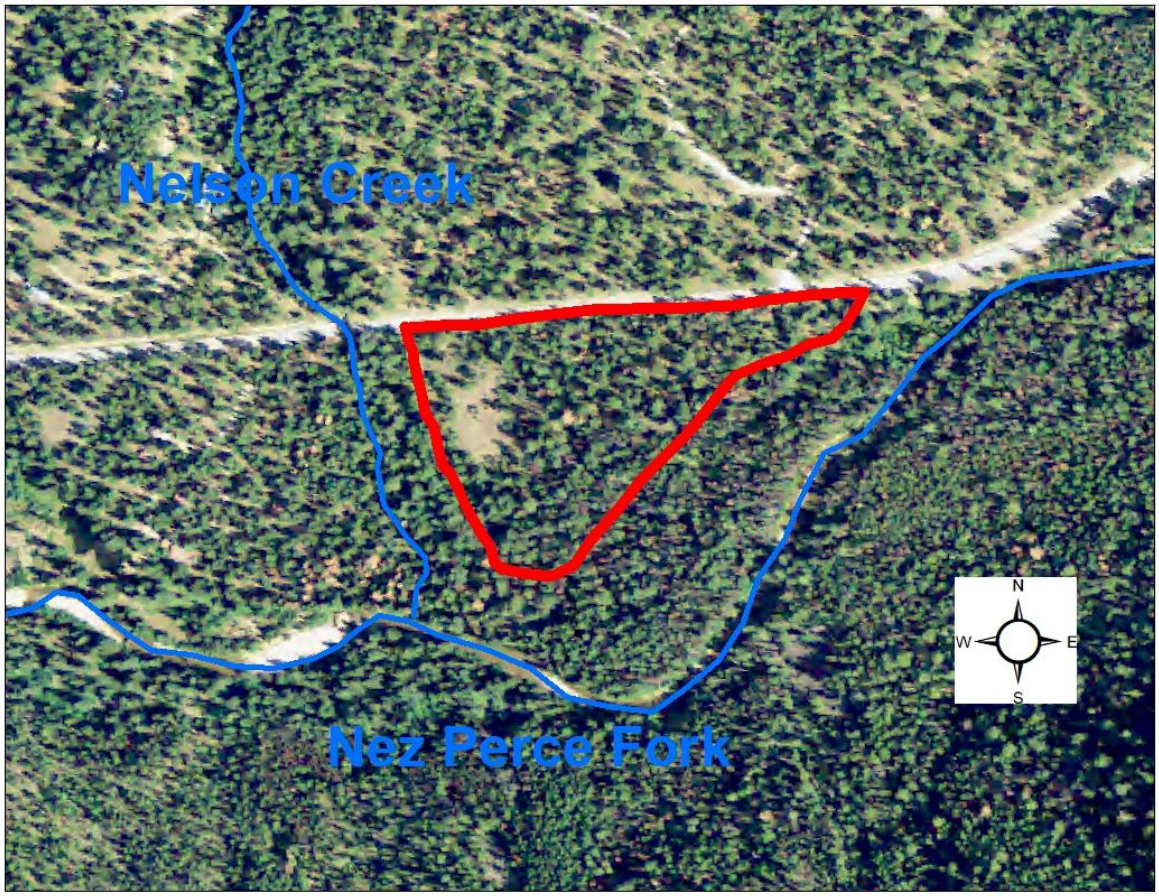
1. How would the commercial harvest of trees (live and dead) in the RHCAs affect wood recruitment, shade, and sediment in the Nez Perce Fork, Nelson Creek, the Little West Fork, and the West Fork Bitterroot River?
2. Would the commercial harvest in the RHCAs be consistent with the Forest Plan as amended by INFISH?

Each of the areas is analyzed below.

Area 1. Area 1 is an approximate nine-acre area bounded by Nelson Creek on the west, the Nez Perce Fork on the south and east, and Forest Road (FR) 468 on the north (Photo 1). Area 1 is located in HUC 0204. Within area 1, about 2.75 acres of RHCA is proposed for commercial thinning. Nearly all of this would occur along the western boundary within 150 to 300 feet from Nelson Creek. The southern and eastern boundary is almost entirely located outside of the 300 foot RHCA surrounding the Nez Perce Fork. The boundary of area 1 follows the edge of a dry Ponderosa pine/Douglas fir terrace. The forest type down from the edge of the terrace (i.e. closer to Nelson Creek and the Nez Perce Fork) is dominated by mature spruce/fir. The following design features would apply to area 1.

- No treatment would occur within 50 feet of Nelson Creek, the Nez Perce Fork, or any wetlands.
- Manual thinning of submerchantable trees, piling of slash, and pile burning can occur anywhere outside of these no treatment zones.
- Commercial harvest of live and dead trees would occur > 150 feet from Nelson Creek, and above the edge of the terrace surrounding the Nez Perce Fork. The edge of the terrace is mostly > 300 feet from the Nez Perce Fork. On the extreme east side of area 1, the edge of the terrace necks down to 200 feet from the Nez Perce Fork.
- Harvest (tractor yarding) would occur in winter when adequate winter ground conditions are present.
- Log landings would be located > 300 feet from Nelson Creek and the Nez Perce Fork.

Photo 1.



Key Question #1: How would the commercial harvest of trees (live and dead) in the RHCA of Area 1 affect wood recruitment, shade, and sediment in Nelson Creek and the Nez Perce Fork?

Answer: Restricting commercial harvest of trees to areas > 150 feet from Nelson Creek and the Nez Perce Fork would preserve all of the merchantable-sized trees (> 8 inches diameter at breast height/dbh) that are located within one site potential stream length of the two streams. This restriction would maintain all of the existing shade on the two streams and all of the future wood recruitment. Trees that are located > 150 feet from Nelson Creek and the Nez Perce Fork are too far from the two streams to shade their stream channels or to recruit wood to their channels.

Allowing manual thinning of submerchantable-sized trees (< 8 inches dbh) in the portion of the RHCA between 50 and 150 feet from Nelson Creek and the Nez Perce Fork would maintain all of the existing shade and wood recruitment potential that exists for the two stream channels. The trees that would be cut, piled, and burned would be too small and too far from the stream channels to provide shade or instream wood. Over the course of a couple of decades, manual thinning could improve shade and wood recruitment on a localized scale because it reduces competition for water and nutrients and improves the growth and health of the overstory trees that are capable of shading the stream channels and being recruited for instream wood.

Under winter yarding conditions, restricting tractor yarding to areas > 150 feet from Nelson Creek and the Nez Perce Fork and log landings to areas > 300 feet from the two streams would minimize soil disturbance to a degree that sediment delivery to the two streams would

be extremely unlikely to occur (i.e. discountable). The likelihood of eroded soils moving off-site, passing through 150 feet of riparian area, and entering Nelson Creek or the Nez Perce Fork would be discountable. The slope of area 1 is only about 10%.

For area 1, the conclusion of this analysis is that wood recruitment and shade would be preserved in the short-term and possibly improved in the long-term. The risk of sediment delivery would be discountable.

Key Question #2. Would the commercial harvest in the RHCAs be consistent with the Forest Plan as amended by INFISH?

In order for the commercial harvest of trees from area 1's RHCAs to be consistent with the Forest Plan, it would have to meet all of the following requirements that are contained in INFISH standards TM-1a and TM-1b:

- *Insect damage has resulted in degraded riparian conditions (TM-1a)*: Area 1 meets this requirement. There has been a large amount of mountain pine beetle mortality in area 1 and its adjacent RHCAs, with heavy downed wood loadings.
- *Present and future woody debris needs are being met (TM-1a)*: Area 1 meets this requirement. Two streams border area 1 (Nelson Creek and Nez Perce Fork), and both streams are meeting their Riparian Management Objective for large wood (> 20 pieces per mile). Nelson Creek contains 76 large wood pieces per mile; the Nez Perce Fork contains 65 large wood pieces per mile. Future wood recruitment potential is relatively high along both streams with numerous dead standing snags within one site potential tree length of their channels. The proposed commercial harvest of trees in area 1 would not affect future wood recruitment potential.
- *Harvest activities would not retard (slow down) or prevent the attainment of the Riparian Management Objectives for pools, large wood, water temperature, and stream channel dimension (TM-1a)*: The harvest activities in area 1 would meet this requirement. The trees that would be harvested from area 1's RHCAs are located too far away from stream channels (> 150 feet from Nelson Creek; > 200 feet from the Nez Perce Fork) to affect instream wood recruitment or result in reduced shade on the stream channels. Harvest would be restricted to a gently sloping (approx. 10% slope), dry pine terrace that is located outside of "true" riparian habitat. Restricting tractor yarding to winter conditions on the terrace would have a discountable risk of delivering sediment to streams, and no chance of affecting stream channel dimensions. Based on the findings of Moore et al. (2005), the removal of trees from area 1's RHCAs is unlikely to measurably increase air temperatures within the inner 150 feet of the RHCAs surrounding Nelson Creek and the Nez Perce Fork. That, along with preserving all of the existing shade on the stream channels, would maintain water temperatures. For the reasons described above, the harvest activities in area 1 would not retard or prevent the attainment of the Riparian Management Objectives for pools, large wood, water temperature, and stream channel dimension.
- *Harvest activities would not have an adverse effect on fish (TM-1a)*: The harvest activities in area 1 would meet this requirement. Existing habitat conditions would be maintained in Nelson Creek and the Nez Perce Fork. There would be no adverse effects on fish.
- *A watershed analysis has been completed that documents how INFISH standard TM-1a would be met by allowing timber harvest to occur within the RHCAs (TM-1a)*: This document meets this requirement.
- *Silvicultural treatments are needed to create vegetative conditions that help to attain the Riparian Management Objectives for pools, large wood, water temperature, stream channel dimension (TM-1b)*: The main benefit to be gained from the

commercial harvest in area 1 would be a reduced risk of stand-replacing fire in the adjacent RHCAs surrounding Nelson Creek and the Nez Perce Fork. Keeping stand-replacing fire out of the RHCAs would maintain and/or help to attain the Riparian Management Objectives in future decades. Of particular importance is the preservation of the existing overstory shade.

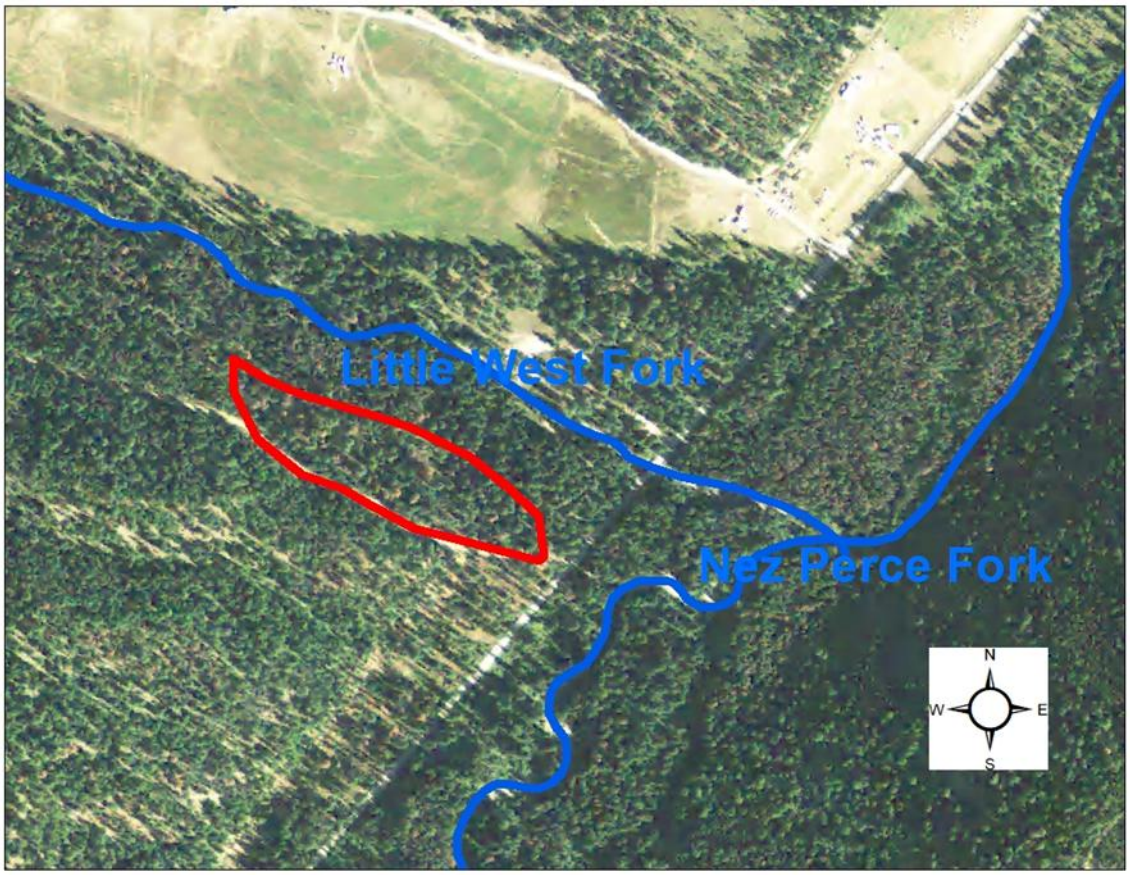
- *Silvicultural treatments would be implemented in a manner that does not retard (slow down) or prevent the attainment of the Riparian Management Objectives (TM-1b)*: Same response as the third bullet above.
- *Silvicultural treatments would not have adverse effects on fish (TM-1b)*: Same response as the fourth bullet above.

The conclusion of this analysis is that the proposed harvest activities in area 1's RHCAs would meet all of the requirements of INFISH standards TM-1a and TM-1b, and would be consistent with the Forest Plan as amended by INFISH.

Area 2. Area 2 is an approximate six-acre area bounded by the Little West Fork on the northeast, FR 5635 on the southwest, and FR 468 on the southeast (Photo 2). It is located in HUC 0203. The portion of the Little West Fork that is adjacent to area 2 flows through two channels. The north channel is the original channel with the bridge crossing over FR 468; the south channel is a more recent channel that formed about 15 years ago. Both channels are perennial and fish-bearing. Nearly all of area 2 is located within the 300-foot RHCA surrounding the south channel. FR 5635 forms the approximate boundary of the 300-foot RHCA. Within area 2, the outer half (150 to 300 feet) of the RHCA is proposed for commercial harvest. This is about three acres. The prescription would be to remove commercial-sized beetle-killed trees and ladder fuel trees. The outer half of the RHCA consists of a mixed conifer forest featuring some large ponderosa pine trees that are being encroached by smaller ladder fuel Douglas fir trees. The inner half of the RHCA is a denser, wetter forest type dominated by spruce and subalpine fir. Area 2 is located on flat terrain. The following design features would apply to area 2.

- No treatment would occur within 150 feet of the south channel of the Little West Fork or within 50 feet of wetlands.
- Manual thinning of submerchantable trees, piling of slash, and pile burning can occur anywhere outside of these no treatment zones.
- Commercial harvest of live and dead trees would occur > 150 feet from the south channel of the Little West Fork.
- Harvest (tractor yarding) would occur in winter when adequate winter ground conditions are present.
- Log landings would be located either on or south/west of FR 5635 (i.e. the upland side of the road opposite the RHCA).

Photo 2.



Key Question #1: How would the commercial harvest of trees (live and dead) in the RHCA of Area 2 affect wood recruitment, shade, and sediment in the Little West Fork?

Answer: Restricting commercial harvest of trees to areas > 150 feet from the south channel of the Little West Fork would preserve all of the merchantable-sized trees (> 8 inches diameter at breast height/dbh) that are located within one site potential stream length of the channel. This restriction would maintain all of the existing shade on the south channel and all of the future wood recruitment. Trees that are located > 150 feet from the south channel are too far away to provide any shade on the stream or to recruit wood to the channel.

Allowing manual thinning of submerchantable-sized trees (< 8 inches dbh) to occur > 150 feet from the south channel of the Little West Fork would maintain all of the existing shade and wood recruitment potential that currently exists on the south channel. The trees that would be cut, piled, and burned would be too small and too far from the south channel to provide shade or instream wood. Over time, manual thinning could improve the growth and health of the overstory trees in the outer half of the RHCA.

Under winter yarding conditions, restricting tractor yarding to areas > 150 feet from the south channel and log landings to areas on or southwest of FR 5635 would minimize soil disturbance to a degree that sediment delivery to the south channel would be extremely unlikely to occur (i.e. discountable). The likelihood of eroded soils moving off-site, passing through 150 feet of flat and densely vegetated riparian area, and then entering the south channel would be discountable. Area 2 consists of flat terrain.

For area 2, the conclusion of this analysis is that wood recruitment and shade would be preserved and the risk of sediment delivery would be discountable.

Key Question #2. Would the commercial harvest in the RHCAs be consistent with the Forest Plan as amended by INFISH?

In order for the commercial harvest of trees from the area 2 RHCA to be consistent with the Forest Plan, it would have to meet all of the following requirements that are contained in INFISH standards TM-1a and TM-1b:

- *Insect damage has resulted in degraded riparian conditions (TM-1a)*: Area 2 meets this requirement. Mountain pine beetle mortality is present and common in area 2. Also, the old growth ponderosa pine trees in area 2 are being encroached by Douglas fir ladder fuel trees, which increases their beetle risk and reduces their chances of surviving future fires.
- *Present and future woody debris needs are being met (TM-1a)*: Area 2 meets this requirement. The Little West Fork borders area 2 and is meeting its Riparian Management Objective for large wood (> 20 pieces per mile). The Little West Fork contains 145 large wood pieces per mile. Future wood recruitment potential is high with numerous dead standing snags within one site potential tree length of both channels. The proposed commercial harvest of trees in area 2 would not affect future wood recruitment potential.
- *Harvest activities would not retard (slow down) or prevent the attainment of the Riparian Management Objectives for pools, large wood, water temperature, and stream channel dimension (TM-1a)*: The harvest activities in area 2 would meet this requirement. The trees that would be harvested from the RHCA are located too far away from the south channel to affect instream wood recruitment or result in reduced shade on the channel. Harvest would occur on flat terrain with winter yarding conditions. The risk of sediment delivery would be discountable, and there would be no effect on stream channel dimensions. The removal of trees from area 2's RHCA is likely to occur on too small of a scale (three acres) and too far from the south channel to measurably increase air temperatures within the inner 150 feet of the RHCA (Moore et al. 2005). That, along with preserving all of the existing shade on the south channel, would maintain water temperatures in the Little West Fork. For the reasons described above, the harvest activities in area 2 would not retard or prevent the attainment of the Riparian Management Objectives for pools, large wood, water temperature, and stream channel dimension.
- *Harvest activities would not have an adverse effect on fish (TM-1a)*: The harvest activities in area 2 would meet this requirement. Existing habitat conditions would be maintained in both channels of the Little West Fork. There would be no adverse effects on fish.
- *A watershed analysis has been completed that documents how INFISH standard TM-1a would be met by allowing timber harvest to occur within the RHCAs (TM-1a)*: This document meets this requirement.
- *Silvicultural treatments are needed to create vegetative conditions that help to attain the Riparian Management Objectives for pools, large wood, water temperature, stream channel dimension (TM-1b)*: The main benefits to be gained from the commercial harvest in area 2 would be (1) reducing the risk of stand-replacing fire in the RHCA; and (2) reducing beetle and fire risks to the old growth Ponderosa pine trees in the RHCA. Keeping stand-replacing fire out of the RHCA and retaining healthy old growth pine trees would maintain and/or help to attain the Riparian Management Objectives in future decades. Of particular importance is the preservation of the existing overstory shade.

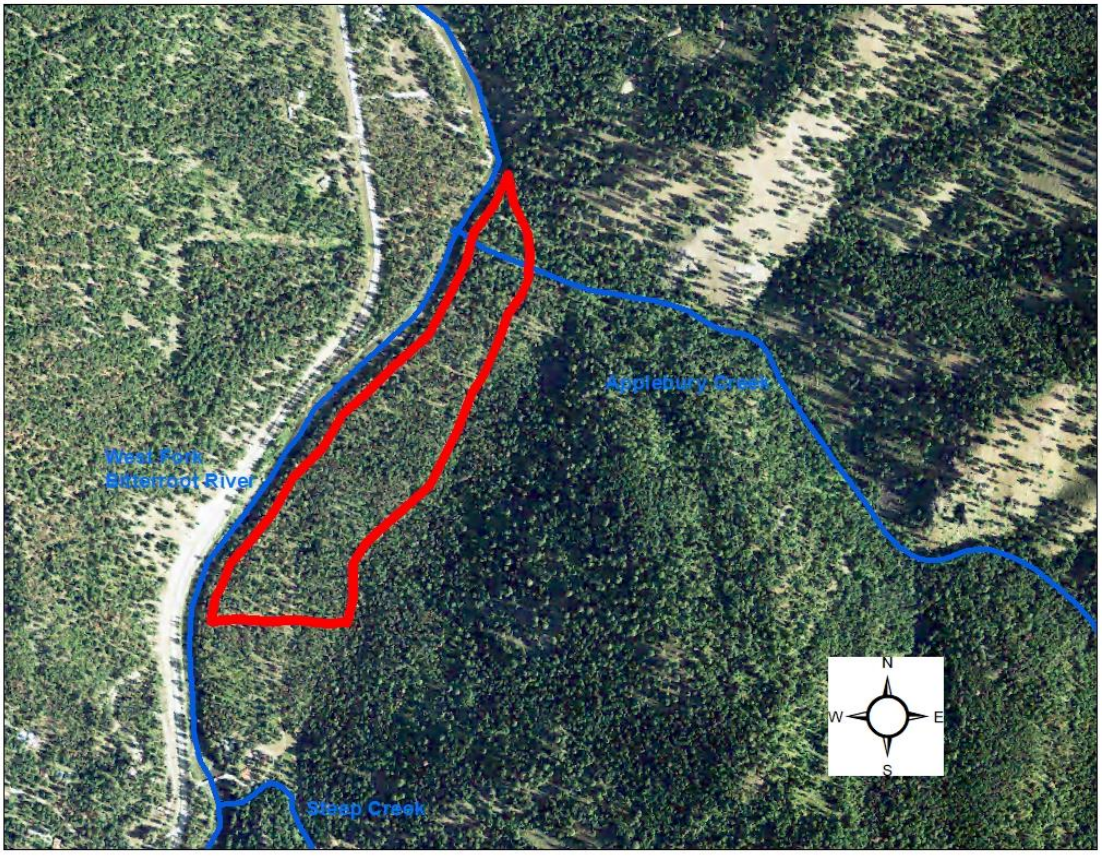
- *Silvicultural treatments would be implemented in a manner that does not retard (slow down) or prevent the attainment of the Riparian Management Objectives (TM-1b)*: Same response as the third bullet above.
- *Silvicultural treatments would not have adverse effects on fish (TM-1b)*: Same response as the fourth bullet above.

The conclusion of this analysis is that the proposed harvest activities in the area 2 RHCA would meet all of the requirements of INFISH standards TM-1a and TM-1b, and would be consistent with the Forest Plan as amended by INFISH.

Area 3. Area 3 is an approximate 28 acre area bounded by Applebury Creek on the north, the West Fork Bitterroot River on the west, the toe of the mountain slope on the east, and the private land boundary on the south (Photo 3). It is located in HUC 0305. Applebury Creek, a small non-fish bearing intermittent stream crosses the northern tip of area 3. Steep Creek, another small non-fish bearing intermittent stream is well outside the area to the south. Area 3 is located on a dry terrace forested with Douglas fir, Ponderosa pine, and lodgepole pine. It is outside the floodplain of the West Fork Bitterroot River. Area 3 is located on flat terrain. Many of the pine in area 3 were killed by the mountain pine beetle; most of the beetle-killed trees have fallen over and downed fuel levels are currently very high. About 13 acres of area 3 are located within the RHCAs surrounding the West Fork Bitterroot River (300-foot RHCA) and Applebury Creek (100-foot RHCA). The prescription would be to remove the dead standing trees (except for snag retention trees) and some of the downed trees that are suitable for firewood. Some harvest of green trees may also occur to reduce ladder fuels around live Ponderosa pine trees. Road access is present on an old road that follows the east side of the unit. The following design features would apply to area 3.

- No treatment would occur below the edge of the terrace that parallels the West Fork Bitterroot River. The edge of the terrace is about 50 feet from the ordinary high water mark of the river. No treatment would occur within 50 feet of Applebury Creek.
- Manual thinning of submerchantable trees, piling of slash, and pile burning can occur anywhere outside of these no treatment zones.
- Downed trees can be winched out of the following areas for firewood harvest: river = edge of terrace to 150 feet; Applebury Creek = 50 to 100 feet. The vehicles doing the winching must stay > 150 feet from the river and > 100 feet from Applebury Creek.
- Commerical harvest of live or dead trees would occur > 150 feet from the river and > 100 feet from Applebury Creek.
- If tractor yarding is utilized, it must occur in winter when adequate winter ground conditions are present. If pick-up trucks with winch cables are used, there would be no restrictions on season of harvest.
- Log landings would be located > 300 feet from the river.
- No equipment (tractor skidders or pick-up trucks) would enter within 150 feet of the river or within 100 feet of Applebury Creek.

Photo 3.



Key Question #1: How would the commercial harvest of trees (live and/or dead) in the RHCA of Area 3 affect wood recruitment, shade, and sediment in the West Fork Bitterroot River?

Answer: All of the commercial-sized trees (live or dead) that are standing within 150 feet of the river would be retained. This restriction would maintain all of the existing shade on the river and all of the trees that could potentially be recruited to the river channel in the future. The trees that are located > 150 feet from the river are too far away to shade the river channel or to be recruited as instream wood.

Allowing manual thinning of submerchantable-sized trees (< 8 inches dbh) in the portion of the RHCA between 50 and 150 feet from the river would maintain all of the existing shade and wood recruitment potential that currently exists. The trees that would be cut, piled, and burned would be too small and too far from the river channel to provide shade or instream wood. Over the course of a couple of decades, manual thinning could improve shade and wood recruitment on a localized scale because it reduces competition for water and nutrients and improves the growth and health of the overstory trees that are capable of shading the river channel and being recruited for instream wood.

Allowing dead trees that are laying on the ground to be winched out of the zone from 50 to 150 feet from the river would have no effect on river shading or wood recruitment. These downed logs are providing neither. Winching them to areas > 150 feet from the river is expected to produce a small amount of ground disturbance if the winching is done during dry soil conditions; if the winching is done under winter conditions, it is likely to produce nearly no soil disturbance.

If tractor yarding is used in area 3, it would be restricted to winter conditions, and to areas > 150 feet from the river. Under those conditions, there would be minimal soil disturbance and a discountable risk of delivering any sediment to the river. The likelihood of eroded soils moving off-site, passing through 150 feet of flat, vegetated terrace, and entering the West Fork Bitterroot River would be discountable. The slope of area 3 is flat.

If pick-up trucks are used to commercially harvest firewood in area 3, there would be no restriction on season of harvest, but the trucks would still be prohibited from entering within 150 feet of the river channel. This type of harvest is anticipated to produce a negligible amount of ground disturbance and no sediment delivery to the river.

In area 3, the conclusion of this analysis is that wood recruitment and shade would be preserved and there would be a discountable risk of sediment delivery.

Key Question #2. Would the commercial harvest in the RHCAs be consistent with the Forest Plan as amended by INFISH?

In order for the commercial harvest of trees from area 3's RHCAs to be consistent with the Forest Plan, it would have to meet all of the following requirements that are contained in INFISH standards TM-1a and TM-1b:

- *Insect damage has resulted in degraded riparian conditions (TM-1a)*: Area 3 meets this requirement. There has been a large amount of mountain pine beetle mortality in area 3 and its RHCAs, with heavy downed wood loadings.
- *Present and future woody debris needs are being met (TM-1a)*: Area 3 meets this requirement. The portion of the West Fork Bitterroot River that borders area 3 contains 33 large wood pieces per mile, which meets the Riparian Management Objective for large wood (> 20 pieces per mile). The area within 150 feet of the river contains numerous dead standing snags that would all be retained and would potentially provide for future recruitment.
- *Harvest activities would not retard (slow down) or prevent the attainment of the Riparian Management Objectives for pools, large wood, water temperature, and stream channel dimension (TM-1a)*: The harvest activities in area 3 would meet this requirement. The trees that would be harvested from the outer half of the river RHCA are located too far away from the river channel (> 150 feet) to affect instream wood recruitment or result in reduced shade on the river. The terrain where the harvest would occur is a flat, dry pine terrace which lacks any "true" riparian habitat. Restricting tractor yarding to winter conditions on the terrace would have a discountable risk of delivering sediment to the river, and no chance of affecting river channel dimensions. Based on the findings of Moore et al. (2005), the removal of trees from area 3 is unlikely to measurably increase air temperatures within the inner half of the RHCAs surrounding the West Fork and Applebury Creek. That, along with preserving all of the existing shade on the channels, would maintain water temperatures. For the reasons described above, the harvest activities in area 3 would not retard or prevent the attainment of the Riparian Management Objectives for pools, large wood, water temperature, and stream channel dimension.
- *Harvest activities would not have an adverse effect on fish (TM-1a)*: The harvest activities in area 3 would meet this requirement. Existing habitat conditions would be maintained in the West Fork Bitterroot River, with no adverse effects on fish. Applebury Creek is fishless.
- *A watershed analysis has been completed that documents how INFISH standard TM-1a would be met by allowing timber harvest to occur within the RHCAs (TM-1a)*: This document meets this requirement.

- *Silvicultural treatments are needed to create vegetative conditions that help to attain the Riparian Management Objectives for pools, large wood, water temperature, stream channel dimension (TM-1b)*: The main benefit to be gained from the commercial harvest in area 3 would be a reduced risk of stand-replacing fire in the RHCA surrounding the West Fork Bitterroot River. Keeping stand-replacing fire out of the RHCA would maintain and/or help to attain the Riparian Management Objectives in future decades. Of particular importance is the preservation of the river's existing overstory shade. The West Fork has already lost about 35% of its overstory shade (MDEQ, 2005: pg 212), so preserving what is left is important.
- *Silvicultural treatments would be implemented in a manner that does not retard (slow down) or prevent the attainment of the Riparian Management Objectives (TM-1b)*: Same response as the third bullet above.
- *Silvicultural treatments would not have adverse effects on fish (TM-1b)*: Same response as the fourth bullet above.

The conclusion of this analysis is that the proposed harvest activities in area 3's RHCAs would meet all of the requirements of INFISH standards TM-1a and TM-1b, and would be consistent with the Forest Plan as amended by INFISH.

Step 4. Description of reference conditions

The purpose of step 4 is to explain how ecological conditions have changed over time as a result of human influence and natural disturbances. References are developed for comparison with current conditions and with key management plan objectives.

Step 5. Synthesis and interpretation of information.

The purpose of step 5 is to compare existing and reference conditions of specific ecosystem elements. Watershed analyses should include and explain significant differences, similarities trends and their causes. Interdisciplinary and interagency interactions and their outcomes should also be discussed in this step.

Steps 4 and 5 have been combined in this section. Existing and reference conditions of the key ecosystem elements identified in Step 2 (large wood recruitment; shade; and sediment delivery) are discussed and compared in this section.

Nez Perce Fork

The key ecosystem elements are below their reference condition in the Nez Perce Fork. The stream is warmer in summer, contains fewer pieces of large wood, and somewhat higher sediment levels than it would have in reference condition. The main human influence that has caused these changes is roads, and particularly the near-stream segments of FR 468.

The Nez Perce Fork watershed (HUC 0204) has a high road density (3.75 miles/mile^2), with 40% of its perennial stream length located within 300 feet of a road. By far, the road with the greatest adverse affect on the aquatic ecosystem is FR 468, which is the main collector road in HUC 0204. FR 468 closely parallels the Nez Perce Fork for most of its length, and about 2.5 miles of FR 468 segments are located within 100 feet of the stream channel (about 2.1 miles of unpaved segments + 0.4 miles of paved segments). This has

caused widespread, permanent reductions in overstory shade along the north side of the creek. The increased solar exposure results in warmer-than-natural stream temperatures in the Nez Perce Fork during the summer months, which in turn contributes to the decline of bull trout and the spread of non-native trout. Summer mean-maximum temperatures in the Nez Perce Fork are likely 1-2° C warmer than they would be in reference condition.

The Nez Perce Fork averages 65 INFISH large wood pieces per mile, which is below its natural potential. The near-stream location of FR 468 has resulted in a permanent reduction in wood recruitment to the stream channel. In reference condition, the Nez Perce Fork would probably contain > 80 INFISH large wood pieces per mile.

Sediment levels in the Nez Perce Fork are believed to be somewhat higher than they would be in the reference condition, but not excessively so. The near-stream segments of FR 468 are the main human-caused sediment source, but they do not deliver large quantities of sediment because the near-stream segments are graveled and relatively flat.

Nelson Creek

The key ecosystem elements are close to their reference condition in Nelson Creek. About 75% of the Nelson Creek watershed is either Inventoried Roadless Area or designated wilderness. The private developments (houses and roads) that border the lower mile of Nelson Creek have negligible impact on the stream channel and its surrounding riparian corridor. Large wood recruitment potential and riparian shading are generally intact, and sediment delivery is not occurring.

Little West Fork

The key ecosystem elements in the Little West Fork are close to their reference condition. About 80% of the Little West Fork watershed (HUC 0203) is either Inventoried Roadless Area or designated wilderness. All of the Little West Fork flows through unmanaged or lightly managed Bitterroot NF lands except for 0.5 miles that flows through the Gene Jones ranch (the lone private inholding in the watershed) near its mouth. The ranch and its developments have minimal impact on the riparian corridor along the Little West Fork.

The Little West Fork averages 145 INFISH large wood pieces per mile, which is near its natural potential. With the exception of small areas surrounding a few bridge crossings, wood recruitment is controlled by natural processes and is functioning at its natural potential.

The same is true for shade. Some minor and scattered reductions have occurred at a few bridge crossings, but overall, stream shading is close to its natural potential and the water temperature regime is largely controlled by natural processes.

Sediment levels in the Little West Fork are very low and the stream bottom is dominated by clean cobble and boulder substrates. Forest roads deliver insignificant quantities of sediment to the Little West Fork. The sediment regime is largely controlled by natural processes.

West Fork Bitterroot River (HUC 0305 portion)

The key ecosystem elements are below their reference condition in the HUC 0305 portion of the West Fork Bitterroot River. The HUC 0305 portion of the West Fork contains an unnaturally altered discharge, temperature, and sediment regime as a result of the operation of Painted Rocks Dam. Large wood recruitment is also reduced, primarily as a result of the near-stream location of the West Fork Highway, but also because the

altered discharge regime does not allow the river to migrate across its floodplain as often as it used to.

The HUC 0305 portion of the West Fork averages 33 INFISH large wood pieces per mile, which is below its natural potential. In reference condition the river would likely contain > 50 INFISH large wood pieces per mile. Highway encroachment and riverfront developments on private lands have permanently reduced wood recruitment along some portions of the West Fork in HUC 0305. About 1.9 miles of the West Fork Highway is located within 100 feet of the river, reducing wood recruitment along 13% of the river's length in HUC 0305.

The HUC 0305 portion of the West Fork is designated as a thermally impaired stream (MDEQ, 2005). In addition to water releases from Painted Rocks Dam, shade losses are also an important source of heating. MDEQ conducted a shade study in the Bitterroot Headwaters TMDL and found that of the 199,396 linear feet of the West Fork's length, 52,093 feet (26%) had lost shade as a result of main roads such as the West Fork Highway, and 16,788 feet (8%) had lost shade because of secondary roads and impervious surfaces (Montana DEQ, 2005: pg. 212). In HUC 0305, about 1.9 miles of the West Fork Highway is located within 100 feet of the river. Shade losses are most pronounced along those near-stream highway segments. There are also approximately 40 private residences, along with assorted outbuildings and secondary roads, that are located within 300 feet of the West Fork in HUC 0305. These developments have also reduced shading along the West Fork in scattered locations. Summer mean-maximum temperatures in the HUC 0305 portion of the West Fork are likely 1-2° C warmer than they would be in reference condition.

The HUC 0305 portion of the West Fork is designated as a sediment impaired stream (MDEQ, 2005). The portion of the river below Painted Rocks Dam (which includes the HUC 0305 portion) is considered to be "sediment starved" as a result of the sediment capture by Painted Rocks Dam (MDEQ, 2005: section 3.0, pg 127). Sediment levels in the HUC 0305 portion of the West Fork are very low, which is indicative of sediment starvation. In reference condition, the HUC 0305 portion of the West Fork would have been more sinuous with numerous channel braids and gravel bars. Its substrate would have contained more sediment and gravels instead of the armored cobble/boulder substrates which currently prevail.

Step 6. Recommendations

The purpose of this step is to bring the results of the previous steps to conclusion, focusing on management recommendations that are responsive to watershed processes identified in the analysis. By documenting logical flow through the analysis, issues and key questions (from step 2) are linked with the step 5 syntheses and interpretation of ecosystem understandings (from steps 1, 3, and 4). Monitoring activities and data gaps are identified that are responsive to the issues and key questions.

This watershed analysis was conducted to determine whether the proposed commercial harvest of trees from the RHCAs in areas 1, 2, and 3 would be consistent with the Forest Plan as amended by INFISH.

Step 2 identified three key elements of the ecosystem (large wood recruitment; shade; and sediment delivery). It also identified two key questions:

1. How would the commercial harvest of trees (live and dead) in the RHCAs affect wood recruitment, shade, and sediment in the Nez Perce Fork, Nelson Creek, the Little West Fork, and the West Fork Bitterroot River?
2. Would the commercial harvest in the RHCAs be consistent with the Forest Plan as amended by INFISH?

Step 3 answered the two key questions for areas 1, 2, and 3, and came up with the following conclusions:

Area 1: Allowing commercial harvest of trees to occur between 150 feet and 300 feet from Nelson Creek and between 200 feet and 300 feet from the Nez Perce Fork would meet all of the requirements of INFISH standards TM-1a and TM-1b. Therefore, it would be consistent with the Forest Plan as amended by INFISH.

Area 2: Allowing commercial harvest of trees to occur between 150 feet and 300 feet from the south channel of the Little West Fork would meet all of the requirements of INFISH standards TM-1a and TM-1b. Therefore, it would be consistent with the Forest Plan as amended by INFISH.

Area 3: Allowing commercial harvest of trees to occur between 150 feet and 300 feet from the West Fork Bitterroot River would meet all of the requirements of INFISH standards TM-1a and TM-1b. Therefore, it would be consistent with the Forest Plan as amended by INFISH. The only treatments that would occur in the Applebury Creek RHCA would be manual thinning, piling, and pile burning. These are also consistent with INFISH standards TM-1a and TM-1b.

The commercial harvest of trees from the RHCAs of areas 1, 2, and 3 would not cause further degradation of the thermal and siltation impairments in the West Fork Bitterroot River. The harvest activities have been designed in a manner that would preserve all of the existing shade on water bodies, would cause no increase in direct solar radiation to any water body, and would adequately preserve riparian microclimate conditions near all water bodies. The risk of delivering sediment to any streams would be discountable.

Steps 4 and 5 describe how the key ecosystem elements compare to reference conditions in the Nez Perce Fork, Nelson Creek, Little West Fork, and HUC 0305 portion of the West Fork Bitterroot River.

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